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ABSTRACT

This series of seventeen modules was designed for use in teaching future elementary-school teachers methods for mathematics instruction. Each module is devoted to a general topic of importance to the elementary mathematics curriculum, and contains an overview, a statement of the module objective, a plan for preassessment, a list of several enabling objectives, a list of suggested activities, and suggested posttest plans. Module topics are: (1) introduction, (2) aids to teaching, (3) geometry, (4) sets and related topics, (5) place value, (6) numbers and numerals, (7) number theory, (8) real numbers, (9) addition and subtraction, (10) multiplication and division, (11) measurement, (12) fractions, (13) decimals, (14) problem solving, (15) graphs and charts, (16) logic, and (17) probability. (SD)

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Component:

CURRICULUM METHODS AND MATERIALS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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MATHEMATICS MODULES

- Introduction
- Aids to Teaching
- Geometry
- Sets, Set Language and Set Operations
- Place Value
- Numbers and Numerals
- Number Theory
- Real Number System and Properties
- Addition and Subtraction
- Multiplication and Division
- Measurement
- Fractions
- Decimals
- Problem Solving
- Graphs and Charts
- Logic
- Probability

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SE 021 177

MATHEMATICS MODULE # 1

"Introduction"

by Arthur Justice

Overview

This module is designed to give you the direction for completing this series of modules on methods of teaching mathematics in the elementary school. In this module the learner will also have presented the basic teaching principles and procedures necessary in today's mathematics programs.

Terminal Objective

The learner will know the basic teaching principles and procedures used in today's mathematics programs. The learner will know how to proceed through the following modules for learning the procedures to teach elementary school mathematics.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to determine a student's readiness for the mathematical program.
2. The learner will be able to select materials pertinant to the skill being taught.
3. The learner will be able to select teaching aides suitable to be used with the ability level of the student.
4. The learner will be able to proceed through the series of modules, self-pacing so as to complete the requirement by the date established by the instructor.
5. The learner will turn in a written evaluation of this module before receiving credit for it.

Enabling Activities

1. The learner will examine the publications, Today's Mathematics; and Mathematics, Goals and Activities K-6, Parts 1, 2, and 3.

"Introduction" (continued, page 2)

2. The learner will read, Today's Mathematics, pp. 3-5.

3. The learner will listen to the tape,"Introduction."

Post-Test

The learner will complete a written test at the 80 percent correct level to receive credit for this module.

MATHEMATICS MODUEL # 2

"Aids to Teaching"

Overview

The day of the teacher who teaches with a textbook in her hand and all her students on the same page, doing the same problems, is over. Today's mathematical programs require a teacher to use as many different teaching aids as she can. The individual differences of children require a teacher to know and use many approaches to teach the same concept. This module is designed to familiarize the teacher with a variety of teaching aids.

Terminal Objective

Upon completion of this module, the teacher will be familiar with teaching aids and sources to locate teaching aids.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to select commercial aids to be used in his teaching.
2. The learner will be able to plan and construct original teaching aids to be used in her teaching.
3. The learner will be able to plan and utilize bulletin boards and flannel boards in her teaching.
4. The learner will write an evaluation of this module before receiving credit for it.

Enabling Activities

1. The learner will examine two catalogs of school supplies and submit to the instructor the names and address of the commercial companies on a 3" x 5" file card.
2. The learner will examine the commercial aids to teaching mathematics located in the Curriculum Materials Center and will also familiarize himself with the exhibit of mathematics textbooks located in the Curriculum Materials Center.

3. The learner will examine Plus, Educational Services, Inc., 1964, and will select three (3) activities to motivate the teaching of a skill. The activities will be written on a 3" x 5" file card and present to the instructor for recording.

4. The learner will examine the publications, Baited Bulletin Boards, Bulletin Board Idea Sources, Bulletin Boards for Holidays and Seasons, Bulletin Boards for Subject Areas, Bulletin Boards for the Middle Grades, E-Z Bulletin Boards and 4-D Bulletin Boards, and will plan, produce, and display a bulletin board to be used in teaching a skill area.

5. The learner will read the publication, How to Make and Use Flannel Boards, and will plan, produce and demonstrate the use of the flannel board in teaching a skill area.

6. The learner will listen to the tape, "Aids to Teaching."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 3

"Geometry"

by Arthur Justice

Overview

Geometry is a part of elementary mathematics and of our everyday lives. Geometric shapes are all around us. Geometric terms like points, lines, planes, and space are part of the space age vocabulary. Man has studied geometry for over 100 years in an effort to improve his understanding of the world in which he lives.

Geometry is divided into two parts, the non-metric and the metric. Non-metric geometry is concerned with the geometric properties of familiar objects and is taught intuitively. The formal, deductive method of instruction is reserved for high school. Metric geometry involves measuring the perimeters, areas, and volumes of geometric shapes. Mathematical patterns often are found in geometric shapes and can then be related to number patterns. Students should be conscious of the relationships and be alerted to look for them.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children the concepts of geometry.

Preasessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to list several of the basic terms of geometry and demonstrate understanding of them by using them correctly in mathematical sentences.

2. The learner will be able to use correct mathematical notation for figures such as line sigment, lines, rays, and angles. (This is not an indusive list, rather it is a suggestion of the types of figures.)

3. The learner will be able to classify angles according to their measures.

4. The learner will be able to use the measures of two angles to tell whether the angles are complementary or supplementary.

5. The learner will be able to use a straightedge and compass to bisect a given angle.

6. The learner will be able to identify simple closed curves in the plane.

7. The learner will be able to classify polygons according to the number of sides that they contain.

8. The learner will be able to classify triangles according to the measures of their angles.

9. The learner will be able to classify triangles according to the measures of their sides.

10. The learner will be able to calculate perimeters and areas of squares, rectangles, parallelograms, and triangles.

11. The learner will be able to apply the "Pythogorean Theorem."

12. The learner will be able to demonstrate understanding of the basic concepts of transformational geometry.

13. The learner will be able to recognize and classify space figures such as prisms, pyramids, cylinders, cones, and spheres.

14. The learner will be able to use mathematical notation to name the parts of any given prism or pyramid.

15. The learner will be able to calculate the volume and lateral area of a prism, given certain facts.

16. The learner will turn in a written evaluation of this module prior to receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 339-349; 383-404; 425-436.

2. The learner will solve Exercise Set #18, pp. 349-350, Today's Mathematics, Exercise Set #20, pp. 405-407, Today's Mathematics; Exercise Set #21, pp. 436-437, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 352-356; 410-417; 439-440

   Middle Grade: pp. 355-357; 415-422; 439-441.

4. The learner will examine, Mathematics, Goals and Activities K-6, Part 1, as directed below:

   Early Childhood: none

   Middle Grade: p. 156

   Mathematics, Goals and Activities K-6, Part 3

   Early Childhood: pp. 10-43; 84; 91; 103-106; 118-123

   Middle Grade: pp. 37-74; 118-123; 138-140; 145-147; 153-161; 165.

5. The learner will read the following articles:

   a. "Developing Geometric Concepts in the Kindergarten," Ida Mae Heard, Arithmetic Teacher, Vol. 16, #3, March, 1969, pp. 229-230.

   b. "Some K-6 Geometry," Irvin Brune, Arithmetic Teacher, Vol. 14, #6, pp. 441-447.

   c. "Geometry All Around Us - K-12," John C. Egsgard, Arithmetic Teacher, Vol. 16, #6, October, 1969, pp. 437-445.

   d. "Creative Mathematics With A Geoboard," Peter Wells, Arithmetic Teacher, Vol. 17, April, 1970, p. 347.

   e. "Teaching Perimeter and Area," Lola May, Teacher, January, 1969, pp. 81-84.

   f. "The Ins and Outs of Polygons," Lola May, Teacher, Vol. 88, #3 November, 1970, pp. 102-103.

6. The learner will listen to the tape, "Geometry."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 4

"Sets, Set Language and Set Operations"

by Arthur Justice

Overview

Most contemporay mathematics programs at the elementary school level are teaching the concepts, language and operations of sets. The subject is taught not for its own sake but to provide techniques for introducing fundamental ideas of mathematics. Modern mathematics emphasizes precise language and exact expression. By using set concepts, we are able to describe mathematical ideas and operations more clearly and more simply than with traditional methods alone.

Terminal Objective

Upon completing this module the learner will be able to explain and demonstrate to children Set Concepts, Set Language, and Set Operations.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will define the term "set" and specify sets by describing or listing their elements;
2. The learner will use diagrams to show whether two sets can be placed in one-to-one correspondence;
3. The learner will identify instances of sets which are empty;
4. The learner will use set notation to specify the cardinal number of a set;
5. The learner will determine whether or not two given sets are equal or equivalent;
6. The learner will determine whether a first set is or is not a subset of a second set;
7. The learner will use set notation to express relationships between sets;
8. The learner will find the union and intersection of a given pair of sets;

9. The learner will use various diagrams to show and interpret relationships between sets.

10. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read Today's Mathematics, 2nd Edition, James W. Hedden, pp. 7-11, 25-35.

2. The learner will solve the Exercise Set 2, pp. 11-12 (Today's Mathematics) and Exercise Set 3, pp. 35-37 (Today's Mathematics) and present to the instructor for recording.

3. The learner will examine the Suggested Activities for Children (Today's Mathematics) as directed below:

   Early Childhood: pp. 13-20; 29-46

   Middle Grade: pp. 20-22; 46-51

4. The learner will examine Mathematics Goals and Activities K-6, Part 1, North Carolina State Department of Public Instruction, as directed below:

   Early Childhood: pp. 10-34

   Middle Grade: pp. 28-38

5. The learner will read the following articles:

   a. "The Need to Master Set Theory," Dr. Lola J. May, Grade Teacher, March, 1966, pp. 59-60; 151.

   b. "Properties of Operations: A Meaningful Study," William J. Oosse, The Arithmetic Teacher, April, 1969.

6. The learner will listen to the tape, "Sets."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to be followed to reach the objective, a statement of materials needed in this lesson, the vocabulary to be used, and an evaluation instrument to assess the success of his teaching.

2. The learner will demonstrate to the instructor, using one aspect of the lesson plan developed ab[illegible] a teaching aid to be used in teaching this concept. This demo[illegible]ation may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 5

"Place Value"

By Arthur Justice

Overview

Any place-value numeration system has a scheme of grouping that is basic to that system. The number of symbols necessary in a particular numeration system is directly related to this basic grouping. For example, in the base-ten system there are ten symbols or digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. With various combinations of these ten digits, any number, no matter how great or small, can be expressed. This is possible because the decimal system makes use of place value and has a special symbol, the zero.

Most arithmetic problems are solved by some form of counting. As societies perfected their systems of counting, they began logically to develop shortcuts. The shortcuts are defined as the four basic operations: Addition, subtraction, multiplication, and division.

Terminal Objective

When the learner has completed this module he will be able to explain and demonstrate to children a comparison of place-value numeration systems and conduct operations in bases other than base-ten.

Preassessment

Similar to the Post Test.

Enabling Objectives

Upon completion of this module, the learn will:

1. Be able to identify the basic features of a place-value numeration system;
2. Be able to represent any given whole numbers in many different bases;
3. Be able to make place-value grids for numerals in decimal and non-decimal systems;
4. Be able to use standard notation, expanded notation, and exponential notation to express numbers in a given base;
5. Be able to construct tables of basic addition and multiplication facts for a given base;
6. Be able to use a table of basic addition facts in solving addition and subtraction examples in any base;

7. Be able to use a table of basic multiplication facts in solving multiplication and division examples in any base;

8. Will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 83-89; 105-111.

2. The learner will complete and present to the instructor for recording Exercise Set 6, pp. 89-90; and Exercise Set 7, pp. 111-112, Today's Mathematics.

3. The learner will examine the Suggested Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 92-99

   Middle Grade: pp. 98-102; 113-114

4. The learner will examine, Mathematics, Goals and Activities K-6, Part I, as directed below:

   Early Childhood: pp. 59-61; 69-72; 81-83; 90-92.

   Middle Grade: pp. 81-83; 90-93; 107-108; 110; 118; 132 134-136; 139; 158.

5. The learner will read the articles listed below:

   a. "Diagnosis of Pupil Performance on Place-Value Tasks," Robert F. Smith, Arithmetic Teacher, Vol. 20, #5, May, 1973.

   b. "Introduction to the Numeration of Two-Place Numbers, " Hitoski Ikeda and Mosu Ando, Reading Teacher, April, 1969. pp. 249-251.

6. The learner will listen to the tape "Place-Value."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 6

"Numbers and Numerals"

by Arthur Justice

Overview

As man mastered his environment and developed an organized society he found that a major necessity, in addition to language, was a method of counting and recording numbers. From primitive one-to-one matching to present day application of the binary system in electronic computers, man has created a bewildering variety of ways to count and record numbers. A modern mathematics program should provide a foundation on which children can successfully build and develop number concepts.

Terminal Objective

Upon completing this module the learner will be able to explain and demonstrate to children concepts of whole numbers within a structure of systems of numeration.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to describe the development of the number concept from the concrete level through the semiconcrete, semiabstract and abstract levels.

2. The learner will be able to determine order relationships between whole numbers by using one-to-one correspondences between sets.

3. The learner will be able to apply the law of trichotomy to arrange whole numbers in their proper order.

4. The learner will be able to use the symbols $<$, $=$ $>$, to state order relations between whole numbers.

5. The learner will be able to translate numerals from additive and multiplicative numeration systems into base-ten numerals.

6. The learner will be able to translate numerals from nondecimal place-value systems into base-ten numerals, and visa versa.

7. The learner will be able to group objects in a given set to represent the number of objects in the set by numeral in a variety of place-value systems.

8. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 55-58; 67-74.

2. The learner will solve the Exercise Set #4, p. 59, Today's Mathematics, and Exercise Set #5, p. 74, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine the Suggested Activity for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 61-64; 75-78

   Middle Grade: pp. 75-80

4. The learner will examine, Mathematics, Goals and Activities K-6, Part I, as directed below:

   Early Childhood: pp. 40-59; 63-68; 75-80; 88-89; 92-94; 105

   Middle Grade: pp. 75-80; 82-83; 88-89; 92-94; 105-106; 108-115; 130-132; 136-139.

5. The learner will read the following article:

   a. "What You Always Wanted To Know About Six But Have Been Afraid To Ask," Alan R. Hoffer, Arithmetic Teacher, Vol. 20, #3, pp. 173-180.

6. The learner will listen to the tape, "Number and Numerals."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 7

"Number Theory"

by Arthur Justice

Overview

In this module the learner will take a close look at an aspect of the structural approach to the teaching of mathematics and the parts that make up all numbers (factors). In doing so the learner will consider some of the most efficient approaches to understanding numbers and their factors.

As a result of this close examination of number structure, it is hoped that each learner will recognize the fundamental theorem of arithmetic as an idea that he has known for a long time. But of greater importance is the discovery of the way in which this theorem is basic to a thorough understanding of operations on whole and fractional numbers. The information in this module is necessary background for every elementary school classroom teacher.

Terminal Objective

The learner, upon completion of this module, will be able to explain and demonstrate to children the use of prime number and fractorization as a tool to be used in developing mathematical skills.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to write all possible two-factor product expressions for a given counting number.
2. The learner will be able to draw all possible arrays that represent a given counting number.
3. The learner will be able to classify counting numbers as prime or composite.
4. The learner will be able to write the prime factorization of any given counting number.
5. The learner will be able to state the fundamental theorem of arithmetic.
6. The learner will be able to calculate the greatest common factor for a given set of counting numbers.

7. The learner will be able to calculate the least common multiple for a given set of counting numbers.

8. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 181-200.

2. The learner will solve Exercise Set #12, p. 200, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: p. 202

   Middle Grade: pp. 202-204

4. The learner will examine, Mathematics, Goals and Activities K-6, Part I, as directed below:

   Early Childhood: pp. 95-96

   Middle Grade: pp. 114-115; 116-119; 135
   and in Part 2, pp. 135; 138-139.

5. The learner will listen to the tape "Number Theory."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 8

"Real Number System and Properties"

by Arthur Justice

Overview

One of the prominent features of contemporay mathematics programs is the emphasis on teaching the basic structure of mathematics. Fundamental to the understanding of this basic structure is a knowledge of properties of numbers and operations. While this module deals mainly with operations on whole numbers; the basic structure applies to other numbers--fractional numbers, integers, rational numbers, and real numbers. This module also presents and overview of the real-number system.

Terminal Objective

Upon completion of this unit, the learner will be able to explain and demonstrate to children concepts of properties of operations on numbers.

Preassessment

Similiar to the Post Test.

Enabling Objectives

1. The learner will be able to match integers and rational numbers with points on a number line.
2. The learner will be able to use the number line to illustrate addition and subtraction of integers.
3. The learner will be able to perform the four fundamental operations on integers and rational numbers.
4. The learner will be able to identify equations that illustrate basic properties of the four fundamental operations.
5. The learner will be able to use properties of the identity elements for addition and multiplication to simply expressions.
6. The learner will be able to use the inverse relationship between addition and subtraction to write addition sentences as subtraction sentences.
7. The learner will be able to use additive inverses to solve subtraction examples involving integers.

8. The learner will be able to use the inverse relationship between multiplication and division to write multiplication sentences as division sentences.

9. The learner will be able to state the relationships between the system of real numbers and its subsystem.

10. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 117-124; 321-328.

2. The learner will solve the Exercise Set #8, p. 124, Today's Mathematics, and Exercise Set #17, pp. 329-330, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine the Suggested Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 126-133; 331-332

   Middle Grade: pp. 130-134; 332-335

4. The learner will examine, Mathematics, Goals and Activities K-6, Part 2, as directed below:

   Early Childhood: pp. 29-31; 38-41; 49-50; 55-57; 66-68; 70-71; 73; 77-79; 86-91; 167; 170; 172-175; 178-180; 182-183.

   Middle Grade: pp. 77-79; 86-91; 99-100; 104-106; 108; 123-24; 128; 131; 140; 145; 182; 156-158; 172-175; 178-180; 182-183; 188-191; 195-197.

5. The learner will read the article, "Properties of Operations: A Meaningful Study," William Oosse, Arithmetic Teacher, April, 1969, pp. 271-275.

6. The learner will listen to the tape "Properties of Operations on Numbers."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 9

"Addition and Subtraction"

by Arthur Justice

Overview

In the module on Numbers and Numerals, a method was suggested for helping children develop a concept of number by moving gradually from concrete ideas of number involving tangible sets of real objects, to abstract ideas of number not involving real objects at all. It was suggested that we might begin with sets of real objects, then proceed to the cardinal numbers of sets, and finally consider just numbers in relation to each other.

If the child has experienced a rich program of numbers, he should not find the initial instruction in the four fundamental operations difficult to understand. In fact, if early work has been successful, he should move into a study of the number combinations without realizing that anything new is being attempted. The four fundamental processes, involving both whole numbers and fractions, compose the core of the program in computational arithmetic. The teacher who helps children achieve an understanding and mastery of the four fundamental operations, creating interest and avoiding frustration at the same time, gives the students an invaluable tool for everyday living. In this module the first two of the four fundamental operations, addition and subtraction, will be studied.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children the concepts of addition and subtraction.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to define addition of whole numbers in terms of unions of sets.

2. The learner will be able to use the definition of addition to develop the table of basic addition facts for the base-ten system.

3. The learner will be able to illustrate a given addition sentence on the number line.

4. The learner will be able to illustrate a given subtraction sentence on the number line.

5. The learner will be able to explain how basic properties of addition and place value are used in solving addition examples.

6. The learner will turn in a written evaluation of this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 153-158.

2. The learner will solve Exercise Set #10, Today's Mathematics, p. 159 and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 161-166

   Middle Grade: pp. 165-168

4. The learner will examine, Mathematics, Goals and Activities K-6, Part I as directed below:

   Early Childhood: pp. 34-35

   Middle Grade: None

   Mathematics, Goals and Activities K-6, Part 2

   Early Childhood: pp. 12-32; 34-43; 51-59; 74-81; 94-96; 167; 170 172-174; 178

   Middle Grade: pp. 53-59; 74-81; 94-102; 111-116; 121-126; 148; 150-151; 154-158; 178; 190-191; 195

5. The learner will read the following articles:

   a. "Slide Into Addition and Subtraction," Marilyn Gallis, Teacher, April, 1973, p. 65.

   b. "Giving Meaning to the Addition Algorithm," Irv King, Arithmetic Teacher, Vol. 19, #5, May, 1972, pp. 345-348.

   c. "Addition Games," Elvera Suber, Instructor, LXXXI, #9, May, 1972, p. 24.

d. "Renaming in Subtraction," Lola May, Teacher, October, 1968, pp. 106-108.

e. "The Case for A More Universal Number-line Model of Subtraction," Sister Marijane Werner, Arithmetic Teacher, Vol. 20, #1, pp. 61-64.

6. The learner will listen to the tape, "Addition and Subtraction."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 10

"Multiplication and Division"

by Arthur Justice

Overview

Addition and subtraction might be considered the primary operations in arithmetic, since most primitive mathematical needs beyond simple counting were answered by these two operations. As man's need for numbers became more sophisticated, he tried to find more efficient ways to compute and this led to the development of the operations of multiplication and division. Several different techniques of multiplication evolved over the centureis. Multiplication developed much more rapidly than division which was seldom attempted except with small divisiors. The division algorism that we use today was not used until the fifteenth century.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children the concepts of multiplication and division.

Enabling Objectives

1. The learner will be able to demonstrate basic multiplication facts by using sets, Cartesian products, arrays and the number line.

2. The learner will be able to use Cartesian products and other models to explain some of the basic properties of the multiplication operation.

3. The learner will be able to explain how the properties of addition and multiplication can be used to justify the familiar multiplication algorithm.

4. The learner will be able to use number line diagrams to illustrate division examples.

5. The learner will turn in a written evaluation of this module prior to receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 171-179.

2. The learner will solve Exercise Set #11, p. 180, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine, Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 182-188

   Middle Grade: pp. 184-189

4. The learner will examine, Mathematics, Goals and Activities, Part 2, as directed below:

   Early Childhood: pp. 33; 44-50; 59-74; 82-94; 97; 175; 179-180

   Middle Grade: pp. 82-94; 97; 103-110; 113; 117-121; 125-155; 179-180; 182-183; 188-189; 191; 195-197.

5. The learner will read the following articles:

   a. "Time-O-Math," Jim Gibbons, Instructor, Vol. LXXXI, #10, p. 46.

   b. "Presenting Multiplication of Counting Numbers On An Array Mattrix," Merry Schrage, Arithmetic Teacher, December, 1969.

   c. "Division by Zero," Hilda F. Duncon, Arithmetic Teacher, October, 1971, pp. 381-382.

   d. "Clifford's Check for Long Division," Clifford Lopate, Arithmetic Teacher, January, 1971. p. 118.

6. The learner will listen to the tape, "Multiplication and Division."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 11

"Measurement"

by Arthur Justice

Overview

Children grow up with measures of quantity all around them. They see milk, eggs, and cookies sold in quart cartons, containers for a dozen, and pound packages, respectively. Small children watch while an adult uses a tapeline or a ruler to measure articles of various lengths and shapes. They hear questions and statements about time, height, weight, distance and temperature. From these early and often crude beginnings children acquire ideas of denominate numbers. It is the task of the school to deepen these understandings and to bring a preciseness to their use which is needed in our technologically oriented society.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children the concepts of measurement.

Preassessment

Similar to or the same as the Post-Test.

Enabling Objectives

1. The learner will be able to demonstrate understandings of relationships between standard units of measure in the English system and the metric system.

2. The learner will be able to demonstrate understanding of some of the advantages and disadvantages of the English system as compared to the metric system.

3. The learner will be able to convert measurements from the English system to metric system.

4. The learner will be able to convert measurements from the metric system to the English system.

5. The learner will be able to perform operations on denominate numbers.

6. The learner will turn in a written evaluation of this module before receiving credit.

"Measurement" (continued, page 2)

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 361-370.

2. The learner will solve Exercise Set #19, pp. 370-371, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 372-376

   Middle Grade: pp. 375-379

4. The learner will examine, Mathematics, Goals and Activities K-6, Part 3, as directed below:

   Early Childhood: pp. 76-135

   Middle Grade: pp. 102-170

5. The learner will examine the following:

   a. "Brief History of Measurement Systems," U. S. Department of Commerce, Pub. 304A, October, 1972.

   b. "Metric Supplement to Science and Mathematics," Fred J. Helgren, Metric Association, 1973.

   c. "All You Will Need to Know About Metric," U. S. Department of Commerce, Washington, D. C.

6. The learner will read the following articles:

   a. The April, 1973 issue of the Arithmetic Teacher, Vol. 20, #4.

   b. "Measure for Measure," Lynn Olson, Teacher, February, 1971, pp. 92-94.

   c. "Math - Lab V," Lola May, Teacher, Vol. 89, #6, February, 1972.

   d. "Children's Errors in Telling Time And A Recommended Teaching Sequence," Fredricka Reisman, Arithmetic Teacher, March, 1971.

"Measurement" (continued, page 3)

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 12

"Fractions"

by Arthur Justice

Overview

In reviewing the early history of number development, the learner will find that the growth of number ideas is directly related to the increasing complexity of civilization. Just as very limited tallying or matching became insufficient, so eventually whole numbers alone did not satisfy man's needs. It became necessary to describe parts of whole things or groups of things. To meet their need, fractional numbers were created.

The word "fraction" is derived from the Latin "Frangere," meaning "to break". Fractions have always described parts of a "broken" whole. Once the student understands the concept of fractions, the next logical step is to find methods for applying the four fundamental operations to fractional numbers. The fundamental operations and the basic structure that was developed for whole numbers apply also to fractional numbers.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children the concepts of a fraction and the basic operations upon fractions.

Preassessment

Similar to the Post Test.

Enabling Objectives

1. The learner will be able to define the term "fractional number" and write numerals for fractional numbers.
2. The learner will be able to draw diagrams to show models for fractional numbers.
3. The learner will be able to identify the numerator and denominator of a given fraction.
4. The learner will be able to match fractional numbers with points on the number line.
5. The learner will be able to distinguish between proper fractions, improper fractions, and mixed numerals.

6. The learner will be able to represent a given fractional number by a fraction in simplest form.

7. The learner will be able to tell whether a first fractional number is less than, equal to, or greater than a second fractional number.

8. The learner will be able to use number lines, regions, and sets to construct models for addition and subtraction examples involving fractional numbers.

9. The learner will be able to calculate the sum and difference of any two fractional numbers that have the same denominator.

10. The learner will be able to use definitions and basic properties in calculating sums and differences of fractional numbers that are represented by mixed numerals.

11. The learner will be able to use least common multiples, in solving addition and subtraction examples that involve fractional numbers.

12. The learner will be able to use rectangular regions to show models for multiplication of fractional numbers.

13. The learner will be able to apply the standard algorithm for finding the product of two fractional numbers.

14. The learner will be able to express any division example involving fractional numbers as an equivalent multiplication example.

15. The learner will be able to find the reciprocal of any nonzero fractional number.

16. The learner will be able to use reciprocals and the basic properties of multiplication and division of fractional numbers to find the quotient of two fractional numbers.

17. The learner will be able to state and give examples that illustrate the basic properties of multiplication and division of fractional numbers.

18. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 207-216; 233-235; 259-275.

2. The learner will solve Exercise Set #13, pp. 216-217, Today's Mathematics, Exercise Set #14, p. 245, Today's Mathematics, and Exercise Set #15, pp. 275-276 and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 219-227; 248-252; 279-282.

   Middle Grade: pp. 219; 223-229; 248-255; 279-289.

4. The learner will examine, Mathematics, Goals and Activities, Part I, as directed below:

   Early Childhood: pp. 61-62; 73-74; 84-87; 97-104.

   Middle Grade: pp. 84-87; 97-104; 120-127; 129; 140-148; 153; 159.

   Part II. Mathematics, Goals and Activities

   Early Childhood: pp. 52; 68; 74

   Middle Grade: pp. 52; 68; 74; 88; 94-95; 111-115; 117-119; 139-148; 150-151.

5. The learner will read the following articles:

   a. "Sound Thoughts on Piaget's Findings and The Teaching of Fractions," Raymond Duquette, Arithmetic Teacher, Vol. 19, #4 (April, 1972) pp. 273-275.

   b. "Fraction Rummy - A Game," Rowena Roland, Arithmetic Teacher, Vol. 19, #5 (May, 1972) pp. 387-388.

   c. "Display Fractions," Lola May, Grade Teacher, December, 1970, pp. 66-67.

   d. "Fraction Bingo," Maney Cook, Arithmetic Teacher, Vol. 17, #3, March, 1970, pp. 237-239.

   e. "Dominoes In The Mathematics Classroom," Tom Massey, Arithmetic Teacher, Vol. 18, January, 1971, pp. 53-54.

   f. "Pancakes Make Fractions More Meaningful," Virginia Cornwall, Instructor, Vol. VLXXXI, February, 1972. p. 116.

   g. "Cooky Math," Dave Bloom, Instructor, Vol. LXXXII, #5, p. 112.

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 13

"Decimals"

by Arthur Justice

Overview

Any fractional number can be expressed by a fraction in which the numerator is a whole number and the denominator is a counting number. Fractional numbers can also be expressed by decimals. Decimals are extremely convenient and efficient for purposes of computation. They permit the place value notation used for whole numbers to be extended to fractional numbers. For these and other reasons, decimals are widely used in science, industry, and commerce. The concept of place value is fundamental to an understanding of decimals. In order that children may be able to discover the meaning of decimals for themselves, it is necessary for them to review place value.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children the concept of operations upon decimal numbers.

Preassessment

Similar to the Post-Test.

Enabling Objectives

1. The learner will be able to write any given fractional number as a decimal.
2. The learner will be able to express any given decimal in expanded notation.
3. The learner will be able to perform the four fundamental operations on numbers expressed in decimal form.
4. The learner will be able to compare fractional numbers expressed in decimal form.
5. The learner will be able to rewrite any terminating or repeating decimal in fraction form.
6. The learner will be able to use ratios and proportions to describe problem situations in mathematical terms.
7. The learner will be able to use ratios and proportions to solve percent problems.

8. The learner will be able to express numbers in scientific notation.

9. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 293-304.

2. The learner will solve the Exercise Set #16, p. 305, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: None

   Middle Grade: pp. 309-317

4. The learner will examine, Mathematics, Goals and Activities K-6, Part I, as directed below:

   Early Childhood: None

   Middle Grade: pp. 126; 128; 149-152; 153-154; 159

   Mathematics, Goals and Activities K-6, Part II

   Early Childhood: None

   Middle Grade: pp. 96; 116; 120; 148-149; 153; 194.

4. The learner will listen to the tape, "Decimals."

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 14

"Problem Solving"

by Arthur Justice

Overview

One of the most important ways in which we communicate with each other is through language. In language arts classes the child learns to construct complete, meaningful English sentences. He learns that, to be complete, a sentence must express at least one complete idea. To convey ideas, he learns to use particular patterns of words to form complete sentences.

Mathematics, too, is concerned with expressing complete mathematical ideas in particular patterns called mathematical sentences. Most modern mathematics programs introduce mathematical sentences in the primary grades. Basic ideas related to this topic are expanded and reinforced in every later grade. The child learns to translate verbal sentences into mathematical sentences and mathematical sentences into verbal sentences. The techniques of translation are the basis for successful word-problem solving.

Terminal Objective

When this module is completed, the learner will be able to explain and demonstrate to children the concepts of how to translate a mathematical sentence, enabling him to solve word-problems successfully.

Preassessment

Similiar to the Post Test.

Enabling Objectives

1. *The learner will be able to classify the components of a mathematical sentence.*
2. *The learner will be able to tell whether a given sentence is open or closed.*
3. *The learner will be able to tell whether a given closed sentence is true or false.*
4. *The learner will be able to read and interpret set builder notation.*
5. *The learner will be able to tabulate solution sets of simple mathematical sentences.*

6. The learner will be able to write a mathematical sentence to describe a given problem situation.

7. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 137-144.

2. The learner will solve Exercise Set #9, pp. 144-145, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine the Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: pp. 146-419

   Middle Grade: pp. 148-150

4. The learner will examine, Mathematics, Goals and Activities K-6, Part 2, as directed below:

   Early Childhood: pp. 162-163; 168; 176; 186

   Middle Grade: pp. 176; 186; 192-193; 196; 198

5. The learner will read the article, "Open Sentences--The Most Useful Tool in Problem Solving," Louis Cohn, Arithmetic Teacher, March, 1967, Vol. 14, pp. 263-267.

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 15

"Graphs and Charts"

by Arthur Justice

Overview

In this module, the learner will examine some of the properties of relations, study a special kind of relation known as a function, and will see how mathematical relations and functions can be pictured by means of charts and graphs.

Terminal Objective

When the learner has completed this module, he will be able to explain and demonstrate to children how any relationship or function of items may be shown by a graph or chart.

Preassessment

Similar to the Post-Test.

Enabling Objectives

1. The learner will be able to tell whether a given relation is reflexive, symmetric, or transitive.
2. The learner will be able to write a set of ordered pairs for a given relation.
3. The learner will be able to determine whether a given relation is or is not a function.
4. The learner will be able to graph a given relation or function in the number plane.
5. The learner will be able to use the graph of a relation to tell whether the relation is or is not a function.
6. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 445-453.
2. The learner will solve the Exercise Set #22, pp. 453-454, Today's Mathematics, and present to the instructor for recording.

3. The learner will examine Activities for Children, Today's Mathematics, as directed below:

   Early Childhood: None

   Middle Grade: pp. 456-461

4. The learner will examine, Mathematics, Goals and Activities K-6, Part 3, as directed below:

   Early Childhood: pp. 172-183

   Middle Grade: pp. 182-199

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.

2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 16

"Logic"

Overview

Logic is implict in the structural approach used in today's elementary programs. Children use logical reasoning more and more as they progress from the primary grades through the middle grades. At the middle grade level, children are more conscious of the way in which statements are related to one another, and they become more clearly aware of how they reason their way to solutions of problems. This module deals with some of the fundamental notions of logic which are commonly used in mathematics and everyday life.

Terminal Objective

Upon completion of this module, the learner will be able to explain and demonstrate to children some of the fundamental notions of logic which are commonly used in mathematics.

Preassessment

Similar to the Post-Test.

Enabling Objectives

1. The learner will be able to define the terms conjuction, disjunction, and conditional.
2. The learner will be able to read and interpret sentences that use the logical connections $\wedge$, $\vee$, $\rightarrow$, and $\sim$.
3. The learner will be able to tell whether a given compound statement is true or false by using what you know about the truth or falsity of the components and what you have learned about the logical connectives.
4. The learner will be able to use truth tables to determine the validity or invalidity of simple arguments.
5. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 481-485.
2. The learner will solve the Exercise Set #24, pp. 485-486, Today's Mathematics and present to the instructor for recording.
3. The learner will examine the Activities for Children, Today's Magazine as listed below:

   Early Childhood: None
   Middle Grade: pp. 287-488

4. Student Option

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.
2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.

MATHEMATICS MODULE # 17

"Probability"

Overview

Children in the elementary grades can benefit from an introduction to some of the basic concepts of statistics and probability. Some acquaintance with the methods of gathering and organizing data should be a part of each child's mathematical experience. Statistics help people to find answers to questions by making available intelligent methods for using limited amounts of data to arrive at predictions.

The concept of probability is part of our everyday lives. Children already use the terminology and ideas of probability. Most of the mathematics of probability is extremely complex. Very able pupils might be led to discover some of the basic facts of probability intuitively. The topic might be considered enrichment at grades 5 and 6.

Preassessment

Similar to the Post-Test

Terminal Objective

1. The learner will be able to define the terms: "range," "mean," "median," and "mode."
2. The learner will be able to calculate the range, mean, median, and mode for a given collection of facts.
3. The learner will be able to construct a histogram and frequency polygon for a given collection of facts.
4. The learner will be able to demonstrate understanding of the fundamental concepts and definitions of probability.
5. The learner will be able to demonstrate understanding of Pascal's triangle by using it to calculate probabilities.
6. The learner will turn in a written evaluation on this module before receiving credit for it.

Enabling Activities

1. The learner will read, Today's Mathematics, pp. 465-572.
2. The learner will solve Exercise Set #23, p. 472, Today's Mathematics, and present to the instructor for recording.
3. The learner will examine Activities for Children. pp. 474-477, Today's Mathematics.
4. Student option.

Post-Test

1. The learner will develop and present to the instructor a lesson plan to teach the concepts of this module. This lesson plan must contain a clear statement of objectives to be taught, procedures to develop the understanding of the objective, materials to be used, the vocabulary necessary for understanding and an instrument for evaluation to assess the success of the teaching lesson.
2. The learner will demonstrate to the instructor, using one aspect of the above lesson plan, a teaching aid to be used in teaching this concept. This demonstration may be with the instructor only, with a peer group, or with a group of elementary school children.